G12 A Search for Exotic Mesons

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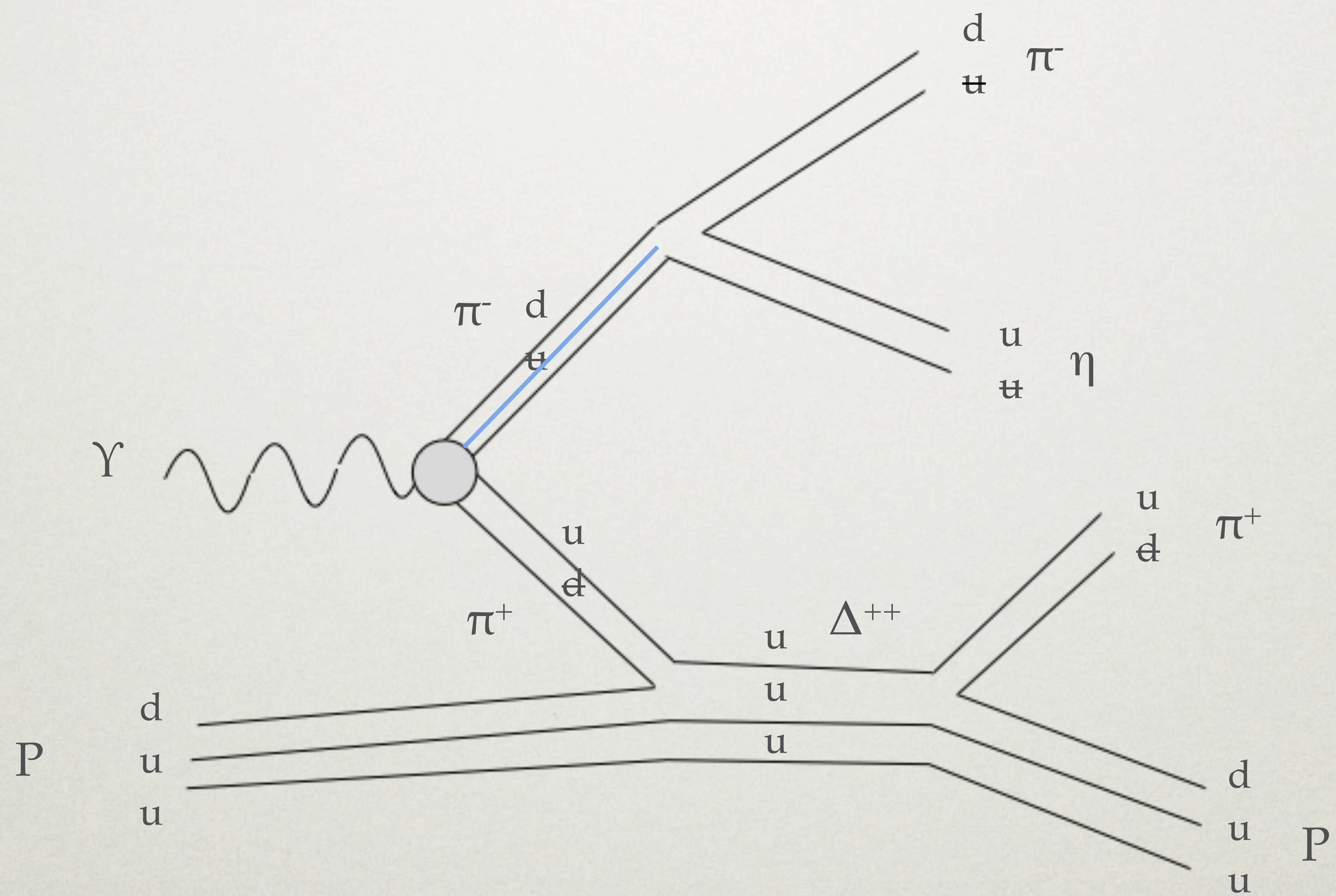
What makes $J^{PC}=1^{-+}$ exotic?

- violates pc-conservation
  - for pi(1400) $J^{pc}=1^{-+}$
    - $P=-(-1)^l = -$ need l to be even
    - $C=(-1)^{l+s}= +$ implies s=0 and J=l, so J is even and excludes J=1
- thought to be quark anti-quark pairs with a vibrating gluon flux-tube
- can have isospin 0 or 1, unlike expected with glue-ball

Purpose

- Theoretical predictions in both gluonic flux-tube models and lattice gauge theory predict lightest hybrids at 1.9 GeV for $J^{pc}=1^{-+}$
- recent experiments using pion beams at Brookhaven showed possible evidence of excited pions at 1400 MeV which is to low for the gluonic hybrid predictions.
- however some controversy over states created by pion-production...
  - resonance behavior was not compelling
  - unnatural parity exchange, not consistent with Breit-Wigner parameters
- photo-production
  - should get good signal 10 times as in pion-production

$\Upsilon + p \rightarrow \Delta^{++} + \eta + \pi^-$



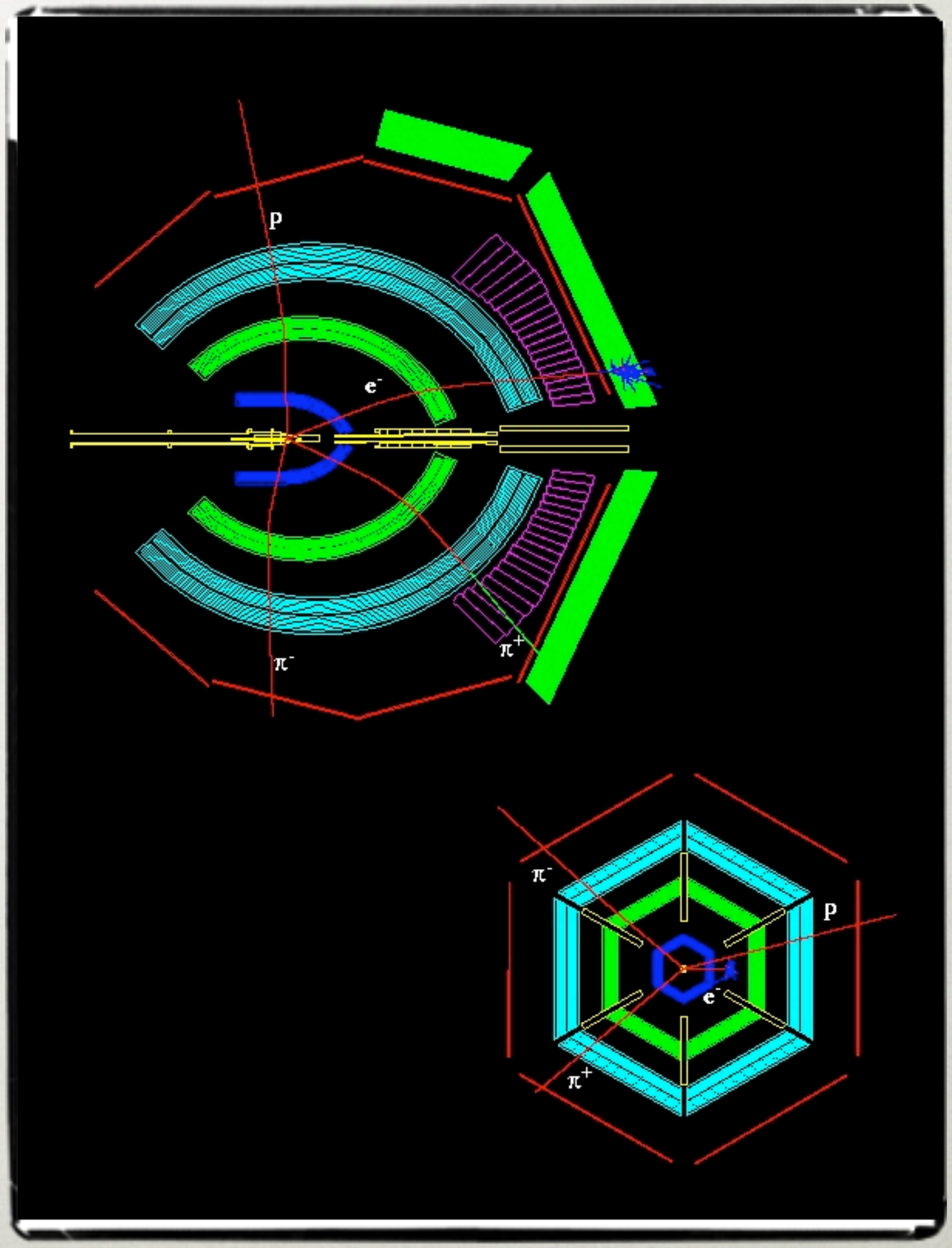
Partial Wave Analysis

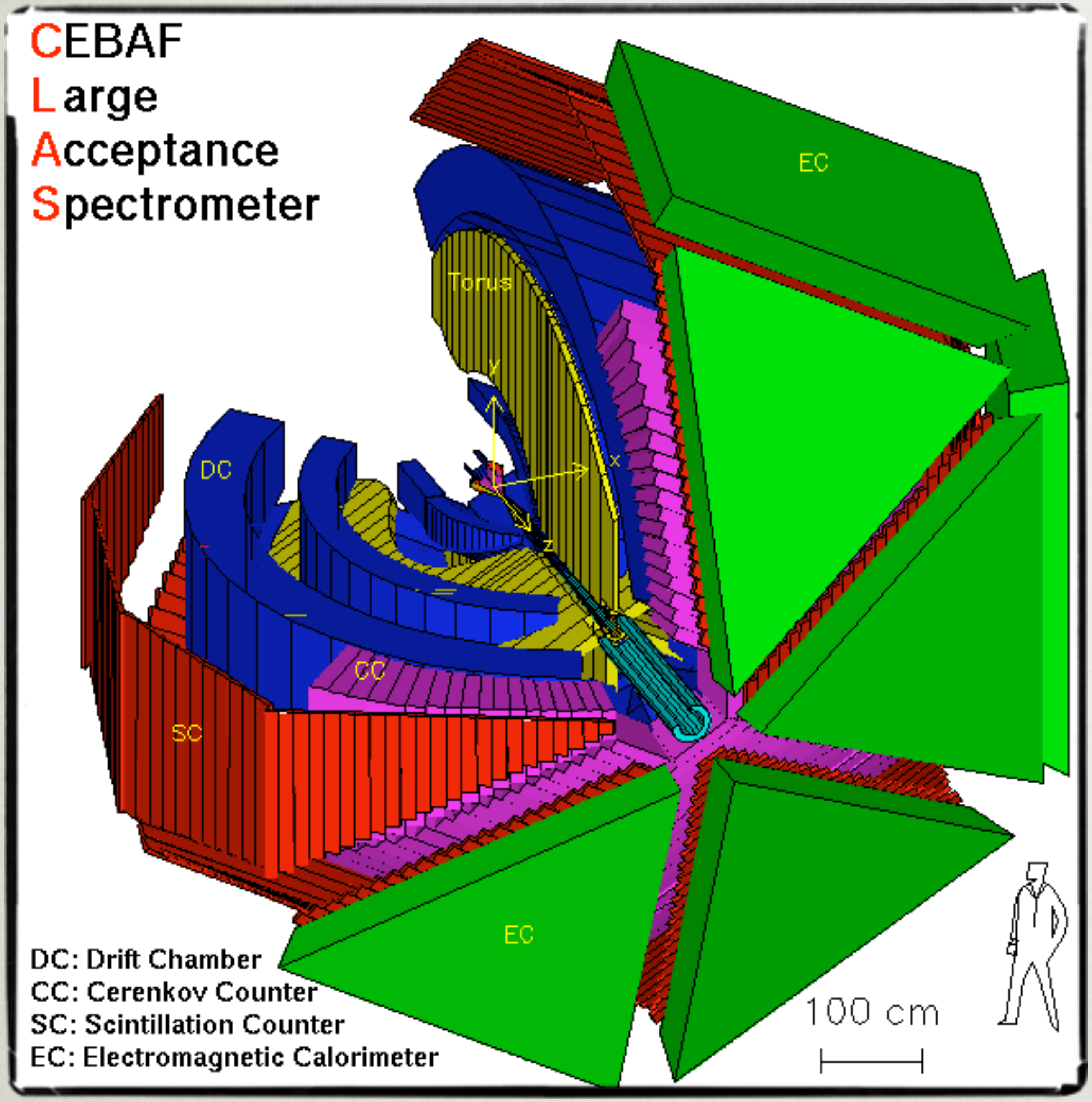
- Partial wave analysis separates J^{pc} states of a meson resonance
    - fits measured observables (angular and kinetic distributions) to determine production strength of each partial wave
- looking to find a peak in the $J^{pc}= 1^{-+}$ intensity plot which would be a violation of the q q-bar model and would show the existence of an excited meson state

Hall B

- designed for experiments requiring simultaneous detection of multiple particles in final states

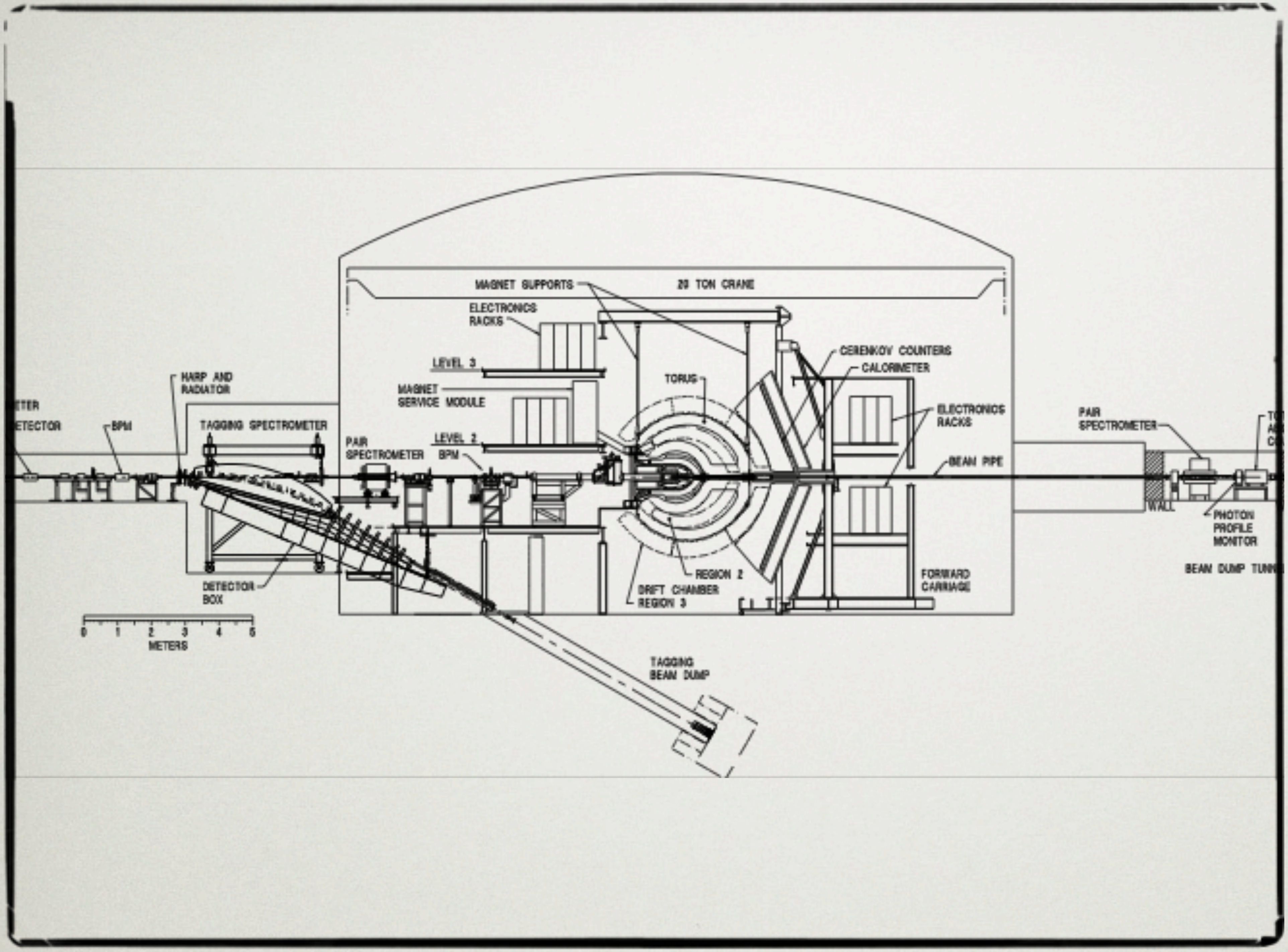
- high counting rates for experiments with luminosity limitations due to tagged photon beam or polarized target operation





- for either electron beam or photon beam
- good resolution for charged particles and neutrals by missing mass technique
- high luminosity
- good particle identification

CLAS


MAGNET SUPPORTS
20 TON CRANE
ELECTRONICS RACKS
LEVEL 3
MAGNET SERVICE MODULE
HARP AND RADIATOR
BPM
TAGGING SPECTROMETER
PAIR SPECTROMETER
LEVEL 2
BPM
TORUS
CERENKOV COUNTERS
CALORIMETER
ELECTRONICS RACKS
BEAM PIPE
PAIR SPECTROMETER
WALL
PHOTON PROFILE MONITOR
BEAM DUMP TUNN
REGION 2
DRIFT CHAMBER REGION 3
FORWARD CARRIAGE
DETECTOR BOX
0 1 2 3 4 5
METERS
TAGGING BEAM DUMP

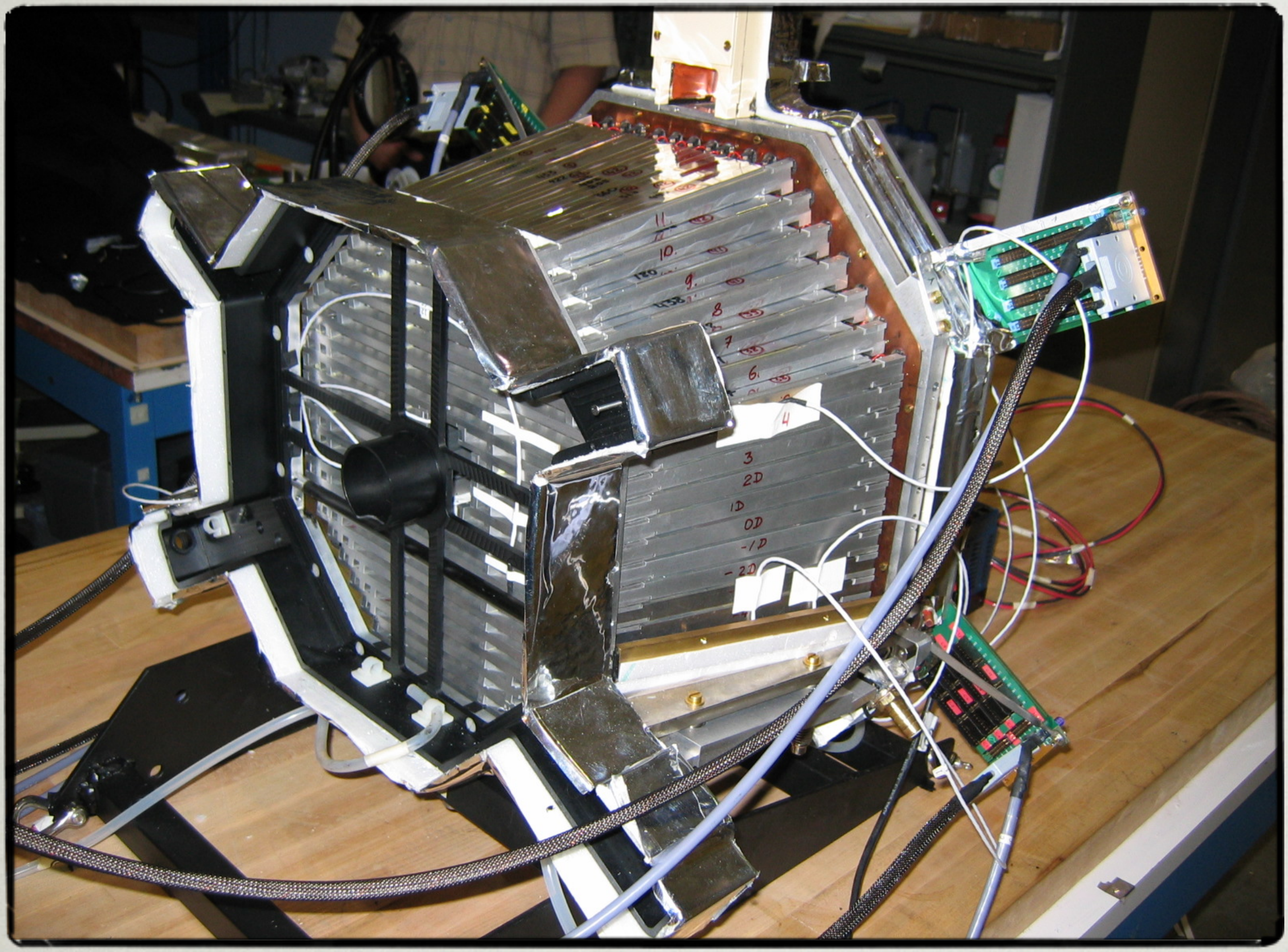
SET-UP

Setup

- electron beam energy of 5.715 GeV, circularly polarized
- beam current 60nA
- 10^{-4} gold radiator
- LH2 target is located at -90 cm from the center of CLAS
- torus current was 1930A (half max)

Additional Detectors

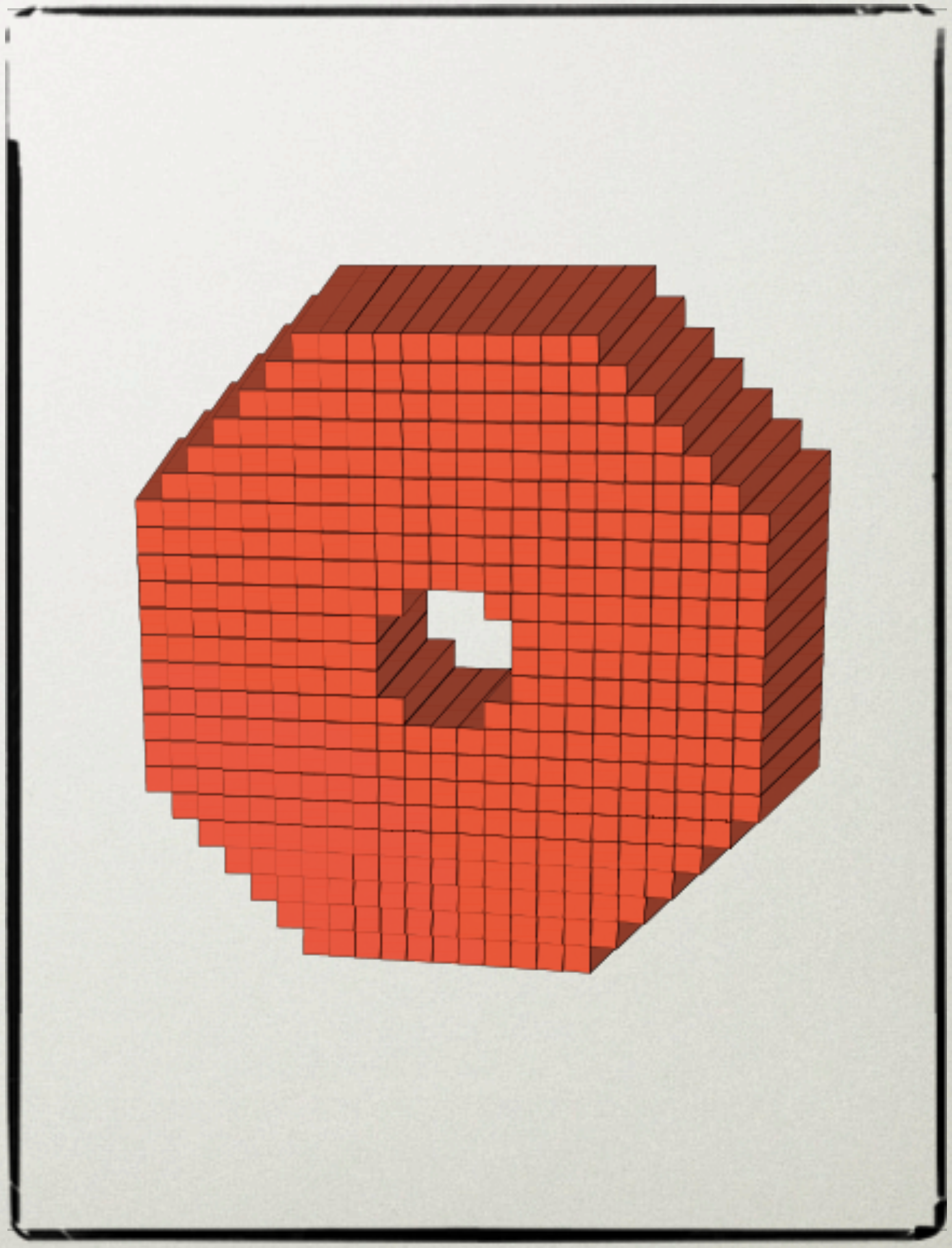
- Needed to detect at small scattering angles since CLAS is not well designed for forward-going systems
- Needs to differentiate between charged and neutral particles
- Must be able to operate in high magnetic field



Inner Calorimeter Hodoscope

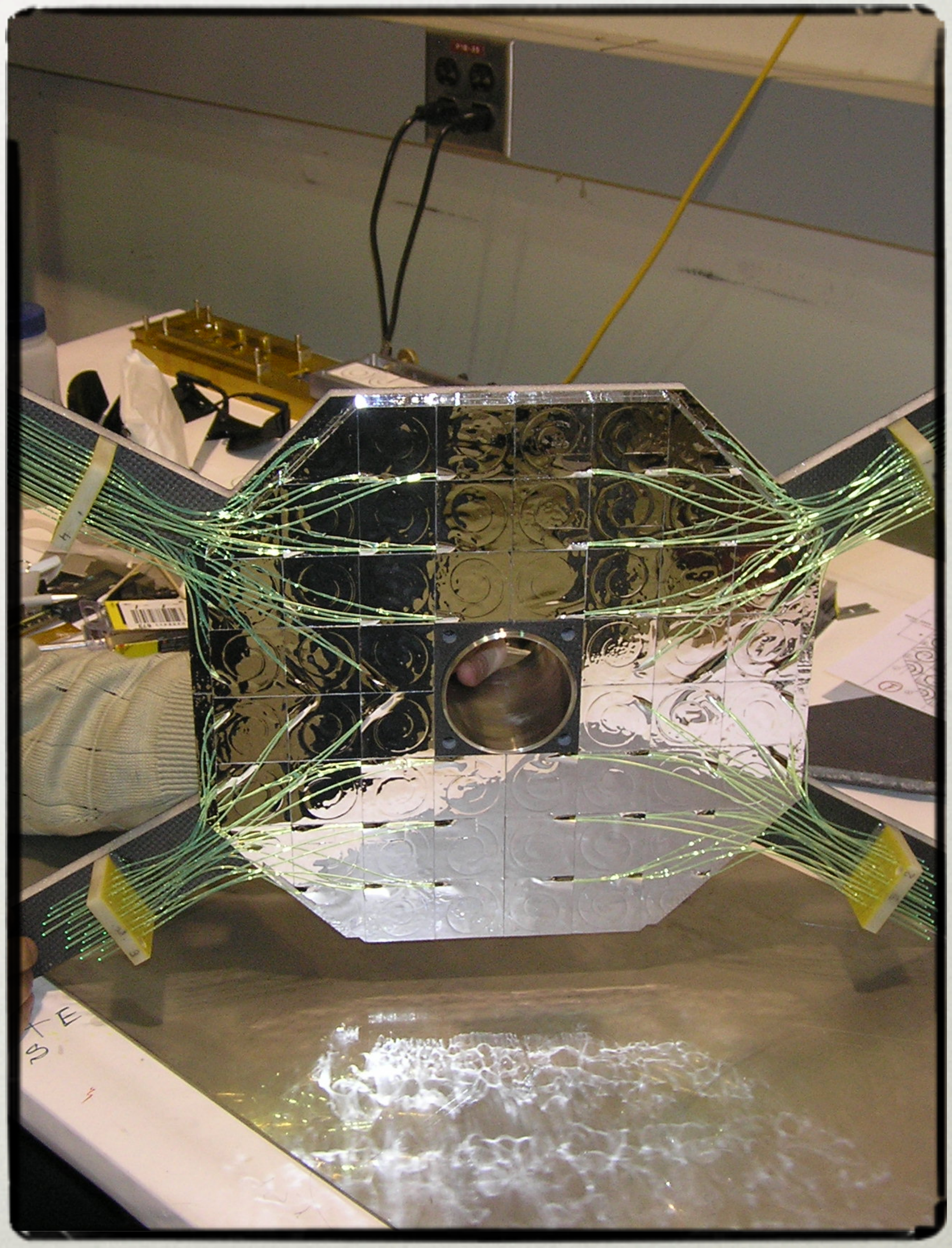
Inner Calorimeter (IC)

- will enhance photon detection at small angles
- good energy and position resolution
- preformed well in 2005 experiment
- Can't separate electrons from photons
- limited resolution at low Q^2



Hodoscope

- made up of 56 scintillator plates
- each plate is 3.8 by 3.8 cm^2 and 1 cm thick
- plates are embedded with wave-length shifting fibers
- fibers read off by Silicon Photo-Multiplier (SiPM) ... functions well under high magnetic field
- detects charged particles but will be undisturbed by neutrals



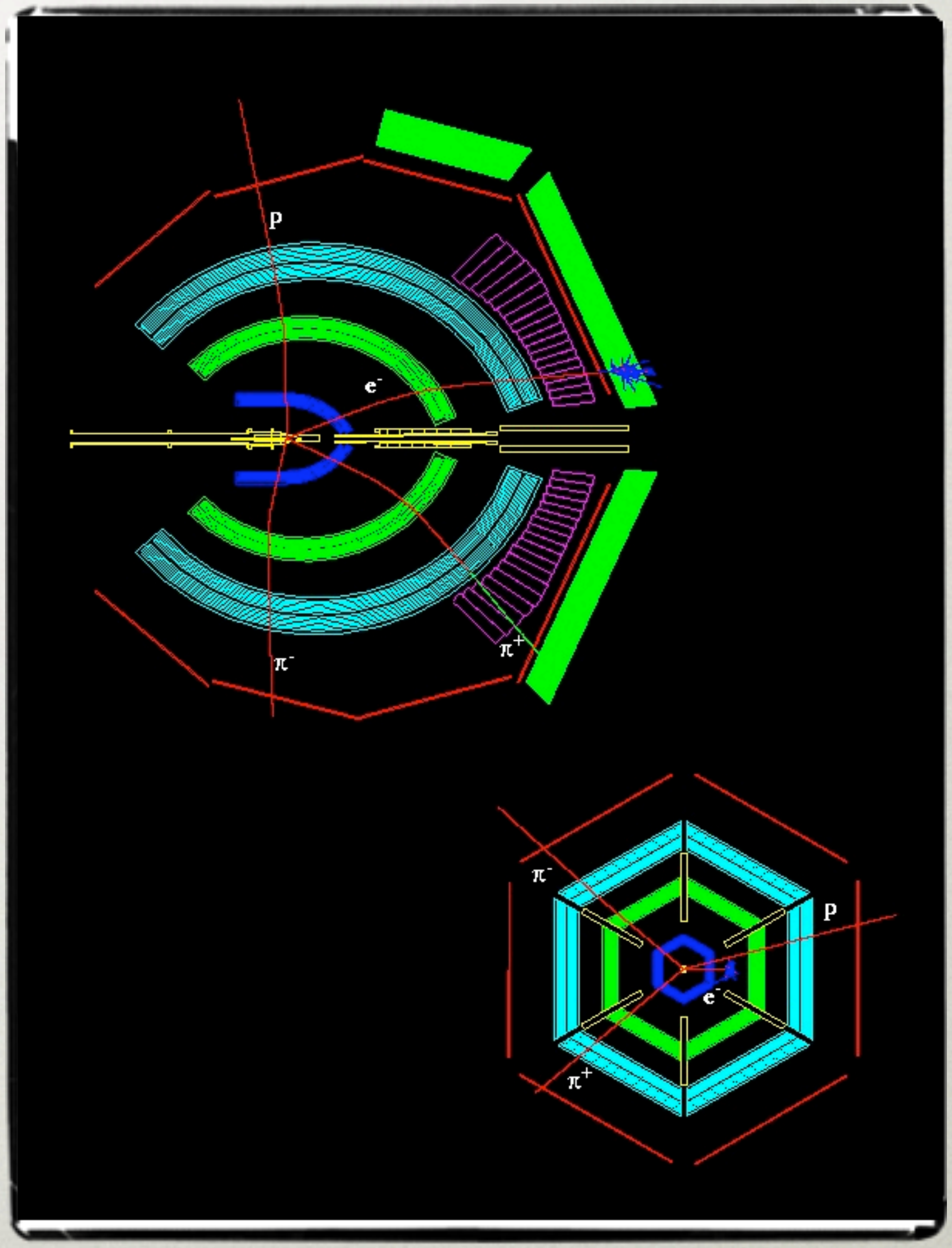
complications:

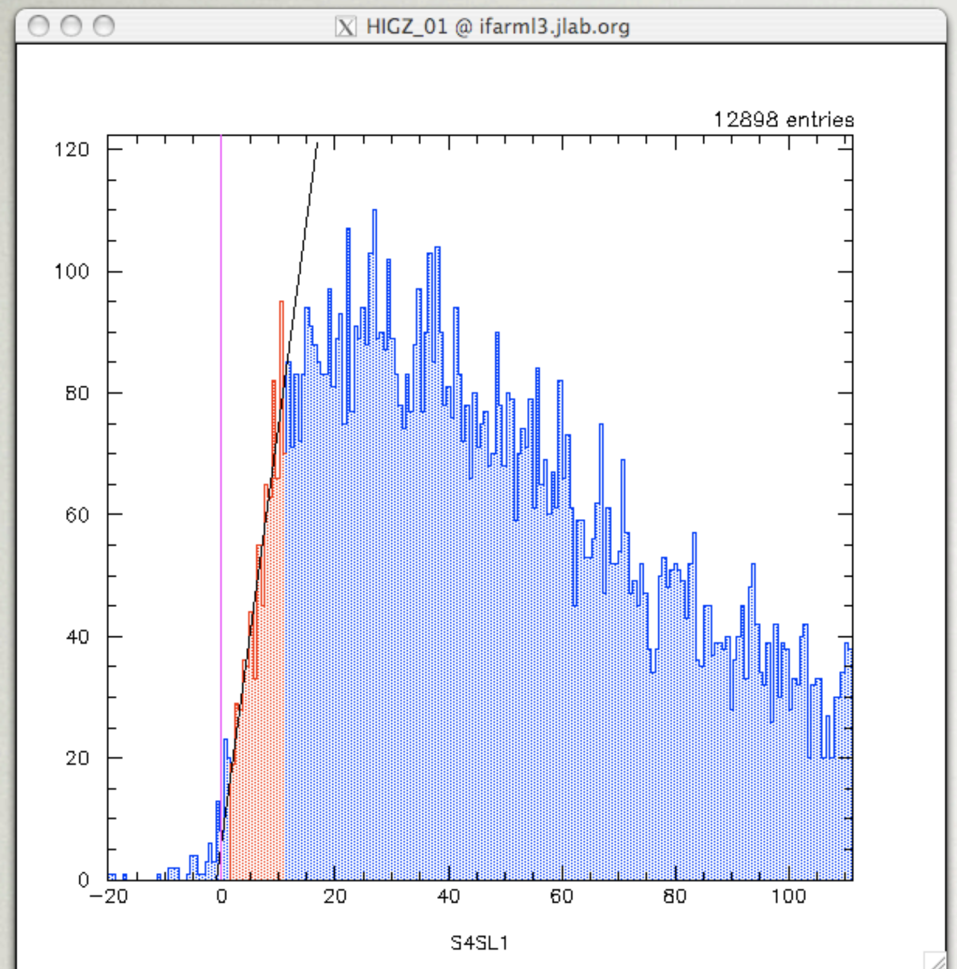
-DOCAs (distance of closest approach) obtained from fitted tracks are biased quantities since initial estimate of drift velocity is used in track determination

-drift cells and isochrones aren't circular, as analysis assumes therefore angle dependent corrections

-R2 chambers are in high and spatially varying magnetic field region. (need to know entry angles of track for drift distance)

-different ionization densities of the tracks from particles w/ different velocity leads to substantial time-walk

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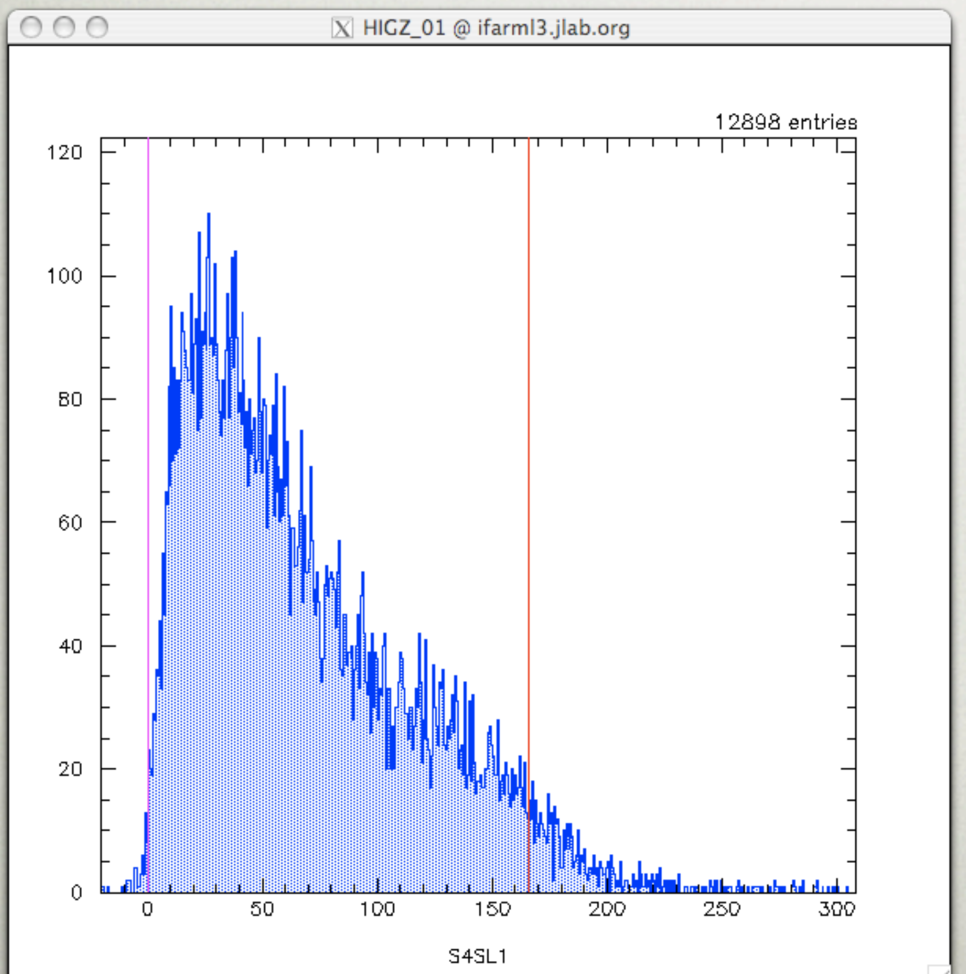
12898 entries
S4SL1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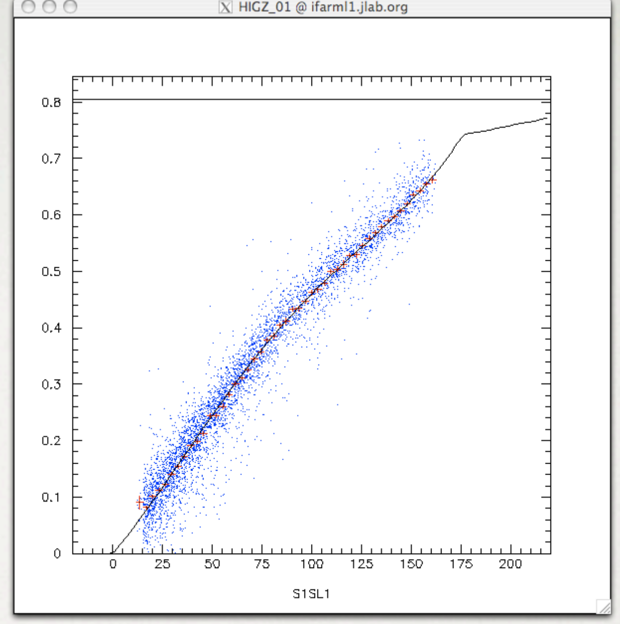
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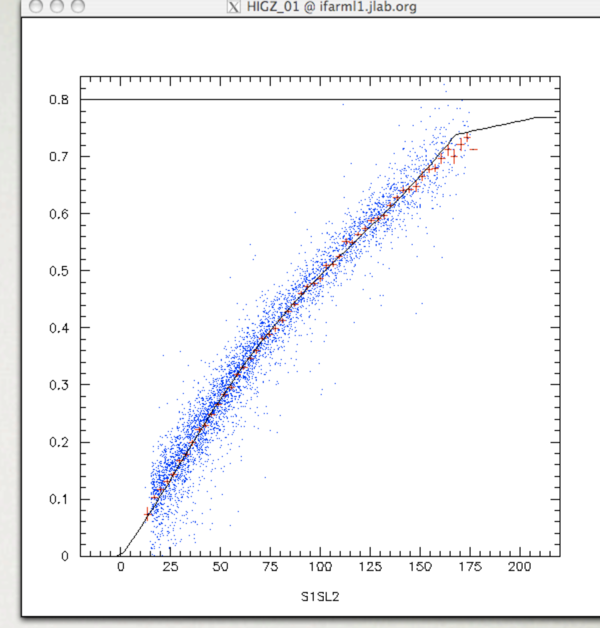
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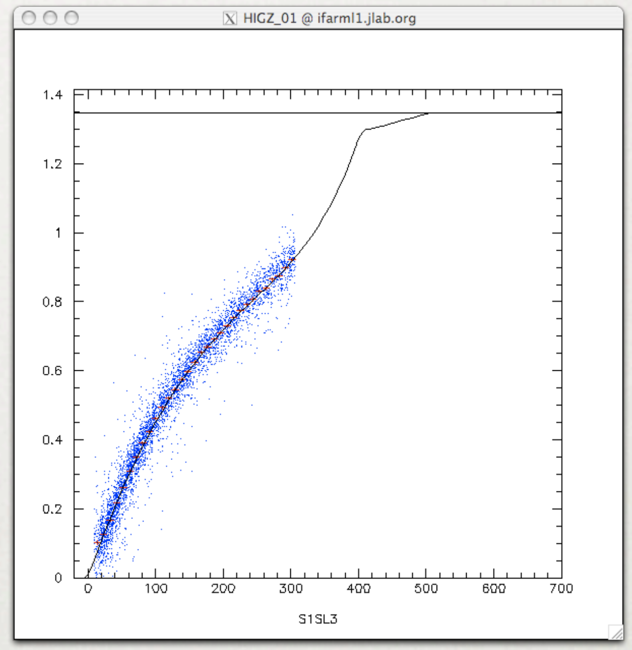
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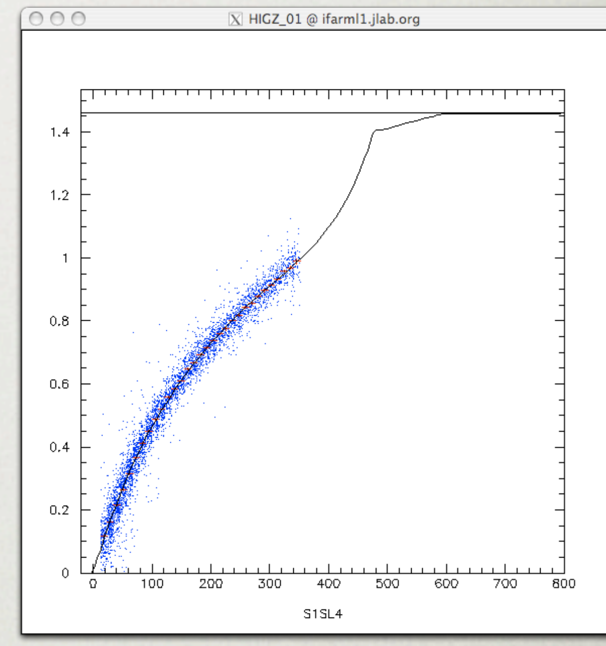
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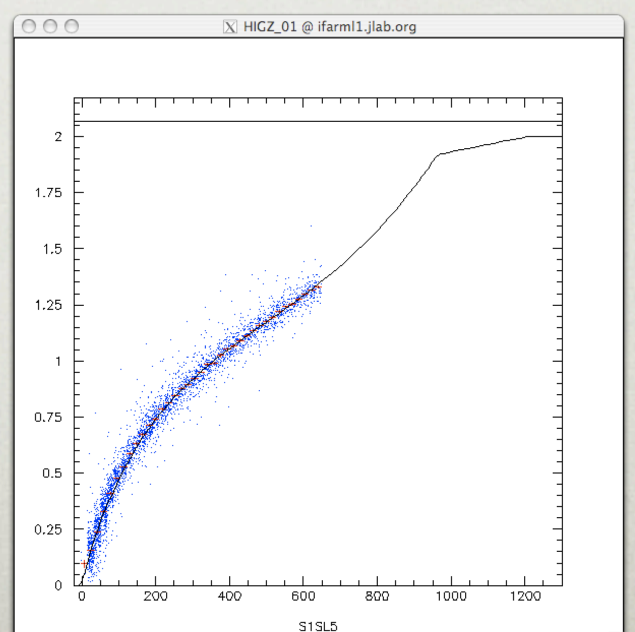
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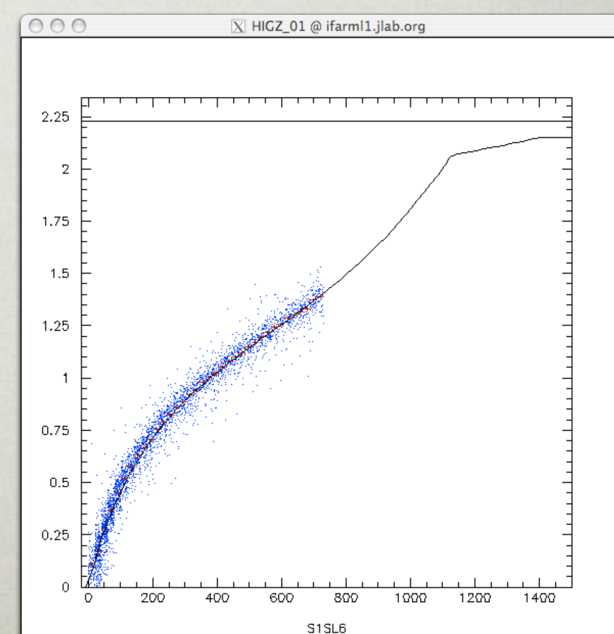
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